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CONCURRENT VALIDITY OF PEDIATRIC BALANCE SCALE WITH COMPUTERIZED POSTUROGRAPHY

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ABSTRACT

Purpose: To establish the concurrent validity of Pediatric Balance Scale (PBS) with the measures of Computerized Posturography **Methods**: Typically developing children between the age group of 3 to 8 years and children with balance impairment were tested **Results**: The total numbers of subjects included in study were 47, mean score on PBS was 50.21+ 4.07. Out of seven items performed on Computerized Posturography six items correlated significantly and only reaching forward with outstretched hand did not correlate significantly. Also Velocity Moment of Computerized Posturography correlated significantly with Centre of Sway in Anterior-Posterior and in Medial-Lateral direction. Maximum correlation was present for standing with feet together (0.902) in A-P direction and for standing unsupported (0.936) in M-L direction. **Conclusion**: Concurrent validity sub items of Pediatric Balance Scale (PBS) with measures of Computerized Posturography is fair to good

Keywords: pediatric balance scale (PBS), berg balance scale (BBS), computerized posturography, balance, children

INTRODUCTION

Balance is an essential part of movement and skill. It is the ability to maintain the centre of body mass over the base of support with minimal sway or maximum steadiness.[1] Static balance is defined as the ability to maintain the centre of gravity within the base of support in a quiet upright position during sitting or standing. Dynamic balance involves maintaining an upright position while the centre of gravity and base of support is moving or the centre of gravity is moving outside the base of support. Both static and dynamic balance is thought to be important and necessary for maintaining posture and for doing activities.[2]

Maintenance of balance requires active efferent information from the proprioceptive, visual and vestibular systems, as well as from the cognitive system, which is integrated and evaluated to generate motor responses that keep the body inside its limits of stability.[3] This integration of system occurs by responding quickly and accurately to all internal and external environmental changes. During functional activities, these changes may occur independently or in any combination.[4]

Development of balance occurs in sequential order. Studies have shown that the greatest development of balance occurs between the age group of 4 to 6 years. And

becoming similar to that exhibited by adult when the child is 7 to 10 years of age.5

Balance skills are an integral part of gross motor abilities and poor balance causes difficulties with functional tasks involved in activities of daily living. Balance deficits in a functional context become an important issue in rehabilitation, and are often the focus of intervention. Therefore, an outcome measure addressing the construct of functional balance is required. A reliable, valid and simple tool to measure balance in children should be valuable to clinicians that are involved in the rehabilitation of the children with balance impairment.[2]

Traditional balance assessments include timed measures of static sitting and standing balance including single limb stance. Standardized examination tools currently utilized by pediatric physical therapists for children with mild to moderate motor impairment include the Bruininks-Oseretsky Test of Motor Proficiency, Peabody Developmental Motor Scale and Gross Motor Function Measure. These scales provide clinicians with valuable information, but may not fully meet their needs to assess a child's functional balance abilities.[5]

Computerized posturography provides the gold standard of measurement of balance, and in literature it is the most widely used reported method to quantify balance measurement.[6] It offers a technology for objective assessment and comprehensive documentation of postural control.[7] The general census is that computerized measures have a greater precision and potential to detect sub clinical balance impairments.[6] But clinical functional tests have a more direct functional relevance and are usually less costly and easier to administer.[7]

One of the clinical functional tests used in Pediatric clinic is Pediatric Balance Scale (PBS) which is a modified version of Berg Balance Scale. It is a 14 item scale and is used to assess the functional balance of children with mild to moderate motor impairments. It identifies need for physical therapy intervention and to monitor progress within a therapeutic program.[8] By nine years of age a child is able to score fully on PBS.[9] And it has a good test-retest reliability (0.99), also clinical observation supports the content validity of PBS.[8] PBS is being correlated with BOTMP (0.73).[10] But PBS is not yet correlated with the standardized Computerized Posturography.

Thus attainment of balance in children occurs sequentially. And various clinical tests have being incorporated to assess the balance. The standardized balance assessment is done by Computerized posturography which gives quantitative balance measures. Pediatric Balance Scale (PBS) involves fourteen items tested for balance in children and requires less time to complete test. And by nine years of age child is able to score fully on PBS.

PBS has been validated with BOTMP. But PBS concurrent validation is not yet established with Computerized posturography measures.

Thus the main objective of the study was to establish the concurrent validity of sub items of PBS with the measures of gold standard assessment of balance that is Computerized posturography.

METHODOLOGY

Typically developing children in the age group of 3 to 8 years and children with balance impairment admitted at Kasturba Hospital, Manipal (India) were taken. The balance testing of children was done in Balance and Vestibular Rehabilitation unit, Physiotherapy department, Manipal, India.

Study design was observational study and convenient sampling method was used. Sample size calculated was 43 and it was calculated by using correlation coefficient formula, that is

$$n = \frac{(Z1-\acute{\alpha}/2 + Z1-\beta)^2}{[FZ(\rho1)-FZ(\rho o)]^2} + 3$$

ρo – population correlation coefficient (0)

ρ1 – sample correlation coefficient (0.48)

ά – significance level (1.96)

1-β – power (1.28)

n= 43

Children included in study were those who were typically developing between the age group of 3 to 8 years, also could understand instructions, weighing more than 10kgs (since posturography machine was sensitive for weights more than 10 kgs), with balance problem scoring less than 56 on PBS from Kasturba Hospital (Manipal) and children who were able to stand at least 1min without support were taken. Uncooperative children were excluded from the study. Instruments used in the study were Good Balance Force Platform (Metitur Ltd, Jyvaskyla, Finland) and the instruments required for assessing balance using PBS.

Procedure: Out of fourteen items of PBS seven items which were static, required minimal trunk movement and were able to be performed on Computerized posturography machine were taken. Out of these seven items; standing unsupported, standing with eyes closed and standing with one foot in front was already present in the Static Measurement of Good Balance posturography machine. Remaining items that is standing with feet together, standing on one foot, turn to look behind and reaching forward with outstretched hand were added in the program.

Following approval from college research committee. Children were taken from Kasturba Hospital, Manipal. Details of the study and procedure were explained to the parents and consent from parents was taken.

Demographic details of the children were taken which included their name, date of birth, height and weight. Children were explained each item of PBS and were made to perform that item on ground first. Appropriate height stools were taken. Items of PBS were performed as per the guidelines. Scores of each item were noted down and total score of PBS was then calculated.

Details of the children were entered on Good Balance Posturography machine. The children were given a rest period of five minutes before starting the test on posturography. They were instructed not to - move their foot, look anywhere else, take support of the railings or anyone else, laugh or talk once the time is set on the machine. Children were then asked to stand on the triangular platform of the machine. A picture was placed at their eye level at the wall in front of them and the children were asked to focus on it while standing. Activity to be performed was selected from the machine and time was set up. Then child performed the activity. Seven items of PBS were performed on posturography machine. And children were given a small gift as a token of appreciation for participating in the study.

Velocity Moment (mm2/sec) and Centre Of Sway (COS) parameters in Anterior-Posterior (mm) and Medial-Lateral

direction (mm) readings were noted down from the Computerized posturography machine. Data was entered and analyzed.

Data Analysis: Data was entered in SPSS 11.5 version. Descriptive statistics was done for the demographic characteristics.

Spearman's rank correlation coefficient was used for mean Velocity Moment (VM – mm^2/sec) of 7 items with total score of PBS. Also Pearson product-moment coefficient of correlation was used for Velocity Moment (VM – mm^2/sec) of 7 item with Centre Of Sway (COS) for both Anterior-Posterior (AP–mm) and Medial-Lateral (ML–mm) direction.

RESULTS

The total numbers of subjects included in study were 47 which included 35 typically developing children between the age of 3 to 8 years and 12 children with balance impairments scoring less than 56 on PBS.

As seen in the table 1 subjects mean score on PBS was 50.21± 4.07 that is the subjects were those who were sensitive to PBS were taken for study.

Table 2 shows that out of all the seven items performed on Computerized Posturography machine, six items mean VM correlated significantly with total PBS score and only one item that is reaching forward with outstretched hand mean VM did not correlate significantly.

Velocity Moment correlated significantly with Centre of Sway in Anterior-Posterior (AP) direction with maximum correlation present for standing with feet together (0.902) and minimum for standing with eyes closed (0.592) as seen in table 3.

And in table 4 it is noted that Velocity Moment correlated significantly with Centre of Sway in Medial-Lateral (ML) direction with maximum correlation present for standing unsupported (0.936) and minimum for turn to look behind (0.757)

DISCUSSION

The main purpose of the study was to find out concurrent validity of items of Pediatric Balance Scale (PBS) with Computerized posturography. Out of fourteen items seven items could not be performed on posturography machine. Thus in all seven items of PBS were performed on machine which included standing unsupported, standing with eyes closed, standing with feet together, standing with one foot in front, standing on one foot, turn to look behind and reaching forward with outstretched hand.

Out of all subjects, one subject was not able to perform standing with one foot in front item and thirty subjects were not able to perform item standing on one foot for ten seconds so their readings were not taken on posturography since time setting has be done on machine before the test procedure.

Negative correlation was present between mean Velocity Moment (VM mm2/sec) of seven items and the total PBS score. Thus it indicates that larger amplitude and speed of sway are indicative of poor functional balance on PBS.

Fair to good (-0.34 to -0.72) amount of significant correlation was present between mean VM of sex item with total PBS score. Similarly moderate amount of correlation (-0.55) were obtained in a study when BBS was correlated with computerized posturography when it was done in elderly.18

Also the moderate correlation between the clinical and laboratory measures of balance indicated that different aspects of balance seem to be captured. Also the amount of postural sway a patient demonstrated seems to reflect only a portion of the control

needed during the more functional measure of balance. Hence both of these measures may be needed during a complete balance assessment.19

Despite of being a sensitive item to pick up balance problem standing on one foot correlated moderate to good only (-0.61). Since only seventeen subjects were able to perform this activity for ten seconds.

Computerized posturography is very sensitive to pick up minimal amount of increase in sway and PBS is not able to identify subjects with minimal balance impairment. Hence, moderate amount of correlation (-0.56) was present between standing unsupported with total PBS score.

Studies have shown that static measures usually correlate with posturography and not the dynamic measures.18 This can possibly explain the fair amount of correlation (-0.45) present between turn to look behind item and PBS score.

Correlation for standing with eyes closed (-0.34) was less as compared to that with eyes open (-0.56), since time for standing with eyes closed was ten seconds and that for eyes open was thirty seconds which could have possibly affected the amount of sway in given period of time. Hence we also suggest that the duration for standing with eyes closed should be increased to thirty seconds for more sensitivity of scale.

No significant correlation was present for reaching forward with outstretched hand (-0.22) since, speed and amount with which children moved was not constant. Also measurements when done on the posturography were influenced by fear of fall and anxiety (Maki1991). But studies done have shown that forward reach test and anterior-posterior stability strongly correlated (0.86) with Posturography.11

Since Velocity Moment (VM – mm2/sec) measures sway in all direction with time it was correlated with Centre Of Sway (COS) in both Anterior-Posterior (AP – mm) and Medial-Lateral (ML – mm) direction. Significant correlation was present between both the COS parameters (AP and ML). Thus this suggests that velocity moment and the amount of sway in children correlates significantly. Correlation was better for Medial-Lateral direction as compared to Anterior-Posterior direction in standing unsupported with eyes open and standing with eyes closed. This could be because of the fact that Anterior-Posterior sway is comparatively minimum during bilateral stance.

Limitations of study: Measurements taken repeated could have lead to learning effect. And sensitive measures like sway path, sway area and Root Mean Square (RMS) were not available in our equipment.

Future Recommendations: To prove the sensitivity and specificity of PBS. And to correlate PBS with community mobility

CONCLUSION

Concurrent validity of Pediatric Balance Scale (PBS) with Computerized Posturography is fair to good

Clinical Significance: This study suggest that PBS is a valid scale and hence substantiates the use of PBS in clinical settings for evaluating balance in children

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Table 1. Demographic characteristic of subjects:

N	47
Gender – Boys	25
- Girls	22
Subjects – Typically developing	35
- Balance problem	12
Age (Mean ± SD years)	5.7 ± 2.01
Height (Mean ± SD cms)	110.3 ± 9.5
Weight (Mean ± SD kgs)	17.73 ± 3.73
PBS total score (Mean ± SD)	50.21 ± 4.07

Table 2. Correlation of total PBS scores with mean Velocity Moment (mm^2/sec) of Computerized posturography:

PBS test items	Mean	SD	r value	p
standing unsupported	194.85	174.68	-0.558	0.001
standing with eyes closed	173.18	191.77	-0.340	0.019
standing with feet together	249.98	266.14	-0.720	0.001
standing with one foot in front	360.81	309.41	-0.650	0.001
standing on one feet	523.69	482.53	-0.606	0.010
turn to look behind	1088.9	1176.4	-0.452	0.001
reaching forward with outstretched hand	1731.49	1451.03	-0.219	0.140

Table 3. Correlation of Velocity Moment (mm^2/sec) and Centre of Sway Anterior-Posterior (mm):

PBS test items (VM)	r value	p value
standing unsupported	0.769	0.001
standing with eyes closed	0.592	0.001
standing with feet together	0.902	0.001
standing with one foot in front	0.827	0.001
standing on one feet	0.674	0.001
turn to look behind	0.618	0.001
reaching forward with outstretched hand	0.639	0.001

Table 4. Correlation of Velocity Moment (mm^2/sec) with Centre of Sway in Medial-Lateral (mm):

PBS test items (VM)	r value	p value
standing unsupported	0.936	0.001
standing with eyes closed	0.885	0.001
standing with feet together	0.875	0.001
standing with one foot in front	0.887	0.001
standing on one feet	0.762	0.001
turn to look behind	0.757	0.001
reaching forward with outstretched hand	0.792	0.001